Practice Question Set For A-Level
Subject : Physics
Paper-2 Topic: Fields And Their Consequences(Magnetic Field)

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Name of the Student:____

Max. Marks : 20 Marks **Time : 20 Minutes**

Mark Schemes

Q1.

(a) Arrow pointing up labelled magnetic force or F_M and arrow pointing down labelled electric force or F_E ✔

As location A is given in the question the base of the arrows do not need to sit exactly on A but arrows, if extended, should pass through A.

Care – in some cases A can look like an arrow head.

1

(b) Statement that electric and magnetic forces balance
OR
$qE = Bqv$
OR
$E = vB$
OR
$1.5 \times 10^5 \times 0.12$ ✔

electric field strength = $E = 1.8 \times 10^4$ (V m^{-1}) ✔

A correct final answer gains both marks

2

(c) (centripetal force or $F_c = \frac{mv^2}{r}$, equals force due to the magnetic field or $F_m = Bqv$)

$\frac{mv^2}{r}$ and hence $\frac{mv}{Bq}$ ✔

Condone use of F to represent both F_c and F_m

Allow an interchange between use of q and Q.

Note F = is required

1

(d) $r\left(=\frac{mv}{Bq}=\frac{1.0\times10^{-26}\times1.5\times10^{5}}{0.12\times1.6\times10^{-19}}\right) = 0.078(1)$ ✔

distance (= 2r) = 0.16 (m) ✔ (0.156 m)

ecf on second mark.

second mark given only if mv/Bq used in a calculation.

2

(e) (using an energy approach)

work done by field equals gain in KE $qV = \frac{1}{2} mv^2$ ✔1a

$$(\text{so } v = \sqrt{\frac{2qV}{m}} = \left(\frac{2\times1.6\times10^{-19}\times\frac{6000}{2}}{1.2\times10^{-26}}\right)^{1/2})$$

mark for using the $V/2$ either in an equation or via a substitution ✔[2a]

= 2.8(3) × 10^5 (m s^{-1}) ✔[3a]
OR
(using a force approach)

Force on ion = ma = qE ✔[1b]

$$a = \frac{6000 \times 1.6 \times 10^{-19}}{1.2 \times 10^{-26} \times d} = 8.0 \times 10^{10}/d$$

Using $v^2 = u^2+2as$)
Mark for using equation for E and equation of motion either in symbols or via a substitution ✔[2b]
v = 2.8 × 10^5 (m s^{-1}) ✔[3b]

[1a] *in words or equation which can be awarded even if the ion is not singly charged (candidates can wrongly think it has a charge of 3e)*

[2a] *for making use of half the pd ie 3000 V*

[3a] *Only allow ecf using 6000V giving*

v = 4.0 × 10^5 m s^{-1}

3

(f) A smaller mass gives a smaller time interval ✔[1]

(The explanation can come from a Force or a Work done approach)
The ions are given the same force ✔[2a]
(so) smaller mass has higher acceleration and smaller time interval ✔[3a]
OR
Work done on ions or kinetic energy gained is the same ✔[2b]
(so) smaller mass is given greater speed and smaller time interval ✔[3b]

Award any two of the three marks

condone use of 'lighter' for 'smaller mass'

3 max 2

[11]

Q2.

(a) $V_{rms}\left(=\frac{V_{peak}}{\sqrt{2}}=\frac{15}{\sqrt{2}}\right) = 10.6\ (\text{V})$ ✓

{allow 11 V to 2 sig figs}

1

(b) (Peak voltage 3 divisions corresponding to 15 V)

y-voltage gain = 5 (V div^{-1}) ✔

1

(c) A horizontal line drawn at 10.6 V ✔

Tolerance – must be between 10 and 11 up from the centre

Allow ecf from (a)

1

(d) (Period T = corresponds to 8 divisions
$T = 8 \times 5.0 \times 10^{-4}$ s = 0.0040 s
Frequency = $1/T$ = 1/0.0040) = 250 (Hz) ✔

Answer only gains the mark.

1

(e) Time constant = 4×10^{-4} (s) ✔$_1$ {only needs 1 sig fig}

The second and third mark can come from the following alternatives.
Note the mark is for the method so allow arithmetic slips and imprecise measurements.

To use a number of small divisions rather than grid divisions is not an arithmetic error. This error comes from not knowing how the oscilloscope is used.
Full marks can be awarded from consideration of the charging part of the cycle.

The equation can be presented in a number of variations using RC or τ for example.

Make use of the equation $V_t = V_0 e^{-\frac{t}{\text{time constant}}}$ ✓$_{2a}$
Substitute values for V_t and V_o (confirmed by the graph) and calculate the (unknown) time constant. ✔$_{3a}$

Typical calculation might be:

$\frac{V_t}{V_0} = \frac{1}{12}$ *in 2 time divisions. Substitution into the equation will give τ*

V_t and V_o both need to be defined in relation to the graph

OR

Ln2 (= 0.69) $= \frac{t_{\frac{1}{2}}}{\text{time constant}}$ ✓$_{2b}$
Substitute time for V to decrease to half its value (confirmed by the graph) and calculate the time constant ✔$_{3b}$

OR
V halves its value in 0.5 time divisions.

Substituting gives τ

$t_{\frac{1}{2}}$ *needs to be defined in relation to the graph*

OR
The voltage falls to $1/e$ or 37% in a time constant ✔$_{2c}$ {owtte}
Find the time that corresponds to this fall in voltage confirmed by the graph (normally the start of the discharge This gives the τ directly) ✔$_{3c}$

OR
37% of 3 divisions is 1.1 divisions which occurs in time ¾ time divisions giving τ

3

(f) Reduce the time-base setting ✔$_{1a}$

Uncertainty is due to the smallness of the divisions and this action means the waveform/trace stretched horizontally/in x-direction. ✔$_{2a}$ {owtte}

OR

Increase the y-gain ✔$_{1b}$

Uncertainty is due to the smallness of the divisions and this action means the waveform/trace stretched vertically/in y-direction. (The trace will need to be moved vertically to fit on the screen) ✔ 2b {owtte}

1 *Stated answer must be a practicable change*

2 *Explanation must refer to both the trace and its relation to uncertainty and follow a correct change.*

2

[9]